Template Matching in Human Body Parts Recognition using Correlation

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Abstract

Object recognition in computer vision is the task of finding a given object in an image. The aim of human body parts recognition is to correctly identify objects in a scene. Template matching is a key component in almost any image analysis process. Template matching is crucial to a wide range of applications, such as in navigation, guidance, automatic surveillance, robot vision, and in mapping sciences. A template is nothing but a sub image which is small. The goal is to find occurrences of this template in a larger image that is to find matches of this template in the image. In this present work, template matching technique is used to recognize the human body parts using correlation In this research work the performance has been studied for number of human images with templates.

Keywords: Object Recognition, Template Matching, Correlation, Performance and Human body parts.

1. INTRODUCTION

As humans, it is easy to detect the position of the letters, objects, numbers, etc. However, making a computer solve these types of problems in fast manner is a very challenging task [1]. Object recognition is a fundamental component of artificial intelligence and computer vision. This method is used in various areas such as science,
Object recognition in computer vision is the task of finding a given object in an image. Humans recognize a large amount of objects in images with little effort, regardless of the fact that the image of the objects may differ somewhat in different viewpoints, in several different sizes or scale even when they are translated or rotated [2]. Objects can even be recognized when they are partially obstructed from view. This task is still a challenge for computer vision systems in general.

2. REVIEW OF LITERATURE

Cross Correlation [3] is the basic statistical approach to image registration. It is used for template matching or pattern recognition. Template can be considered a sub-image from the reference image, and the image can be considered as a sensed image. In [4] the authors have proposed a method of medical image registration by template matching based on Normalized Cross-Correlation (NCC) using Cauchy-Schwartz inequality. They have implemented the algorithm for template matching using NCC in MATLAB. Fawaz Alsaade [5] has proposed a combined approach to enhance the performance of template matching system using image pyramid in conjunction with Sum of Absolute Difference (SAD) similarity measure. Wiedo Hu et al. [6] have proposed a method template matching can be defined as a method of parameter estimation. The parameters define the position of the template. Template matching uses a similarity criterion for locating an object, where one common method calculates a correlation coefficient. This “cross-correlation” yields a result only if the integral is computed over the whole area. The basic idea behind the hit-or-miss transform is that of extracting all pixels within an image that are matched by a given neighborhood configuration, consisting of some arrangement of foreground and background pixels. Reinders [7] present an eye tracking algorithm which is robust against variations in scale, orientation and changes of eye appearances, such as eye blinking. The locations of the eye regions in the different frames are found using template matching. Gavrila et al. [8] clustered full body human templates into a hierarchical structure where the similarity between two templates was defined by the Chamfer distance. For each sliding detection window, the best matching template is found by traversing the tree from root to leaf in depth-first search strategy. Amandeep Kour [9] has proposed a wavelet transformation for preprocessing the face image, extracting edge image, extracting features and finally matching extracted facial features for face recognition. This work so far has been carried out for recognizing human parts like eyes and hands in image processing. However this work has been carried out by Kavitha Ahuja et al. [10] in recognizing parts of objects like cup, flower, butterfly etc.

3. PROPOSED METHOD

This article present the framework of finding a given object in an image. Template matching finds all the points inside an image which match a template. In particular, the best individual matching parts given a detection window are determined using an improved template matching algorithm. Template matching uses a similarity criterion for locating an object, where one common method calculates a correlation coefficient.
A high correlation coefficient is a pixel-by-pixel comparison between the template and the region that indicates a good match.

**Figure 1.** System Overview
3.1 ALGORITHM FOR PROPOSED METHOD

1. Read the original image.
2. Read the template image.
3. Convert the original and template image in to double data type.
4. Calculate the height and width of the original and template image as
   \[ \text{TempDu} = \text{reshape}(\text{TempDu}, \text{TempH} \ast \text{TempW}, 3) \]
5. To check the best correlation found as
   \[ \text{corr} = 0 \]
6. Take the segment of original image same size as the template size.
   \[ \text{segment} = \text{OriDu}(i \cdot (i - 1) + \text{TempH}, j \cdot (j - 1) + \text{TempW}, :) \]
   \[ \text{segment} = \text{reshape}(\text{segment}, \text{TempH} \ast \text{TempW}, 3) \]
7. Find the output
   \[ \text{output} = \text{corr2}(\text{TempDu}, \text{segment}); \]
   \[ \text{if output} > \text{corr} \]
   \[ \text{corr} = \text{output}; \]

3.2. CORRELATION

Correlation is a measure of the degree to which two variables agree, not necessary in actual value but in general behavior. The two variables are the corresponding pixel values in two images, template and source [3]. Cross Correlation is used for template matching or pattern recognition. Template can be considered a sub-image from the reference image, and the image can be considered as a sensed image. The matching process moves the template image to all possible positions in a larger source image and computes a numerical index that indicates how well the template matches the image in that position. Match is done on a pixel-by-pixel basis. (refer Figure 2)

![Figure 2. Method of matching the image using correlation](image)

3.3 TEMPLATE MATCHING

It is a technique used to categorize objects. The goal is to find occurrences of a template, which is a sub-image in a larger image. Template matching techniques compare portions of images against one another. Sample image may be used to recognize similar
objects in source image [10]. Template matching finds all the points inside an image which match a template. Suppose there is a template \( g[i, j] \) and wish to detect its instances in an image \( f[i,j] \). An obvious thing to do is to place the template at a location in an image and to detect its presence at that point by comparing intensity values in the template with the corresponding values in the image. Since, it is rare that intensity values will match exactly, it require a measure of dissimilarity between the intensity values of the template and the corresponding values of the image. Several measures may be defined[12,13]

\[
\text{Max} |f - g | [i, j] \in \mathbb{R} \tag{1}
\]

\[
\sum |f - g | [i, j] \in \mathbb{R} \tag{2}
\]

\[
\sum (f - g)^2 [i, j] \in \mathbb{R} \tag{3}
\]

where \( \mathbb{R} \) is the region of the template.

The sum of the squared errors is the most popular measure. In the case of template matching, this measure can be computed indirectly and computational cost can be reduced. It can simplify:

\[
\sum (f - g)^2 = \sum f^2 + \sum g^2 - 2 \sum fg \tag{4}
\]

Now if it assume that \( f \) and \( g \) are fixed, then \( \sum fg \) gives a measure of mismatch. A reasonable strategy for obtaining all locations and instances of the template is to shift the template and use the match measure at every point in the image. Thus, for an \( m \times n \) template, then compute

\[
M[i,j] = \sum_{k=1}^{m} \sum_{l=1}^{n} g[k, l] f[i + k, j + l] \tag{5}
\]

where \( k \) and \( l \) are the displacements with respect to the template in the image. This operation is called cross correlation between \( f \) and \( g \). Template matching approaches have been quite popular in optical computing: frequency domain characteristics of convolution are used to simplify the computation.
4. METHODOLOGY OF TEMPLATE MATCHING

4.1 CROSS-CORRELATION COEFFICIENT

Correlation is an important tool in image processing, pattern recognition, and other fields. The cross correlation coefficient [3,10,11] is defined as

\[ \gamma(x,y) = \sum_{s} \sum_{t} \delta_{I(x,y)+t} \delta_{T(x,y)} \]

where

\[ \delta_{I(x,y)+t} = I(x+s,y+t) - \overline{I}(x,y) \]

\[ \delta_{T(x,y)} = T(s,t) - \overline{T} \]

\( s \in \{1,2,3,\ldots,p\} \)

\( t \in \{1,2,3,\ldots,q\} \)

\( x \in \{1,2,3,\ldots,m-p+1\} \)

\( y \in \{1,2,3,\ldots,n-q+1\} \)

\[ \overline{I}(x,y) = \frac{1}{pq} \sum_{s} \sum_{t} I(x+s,y+t) \]

\[ \overline{T} = \frac{1}{pq} \sum_{s} \sum_{t} T(s,t) \]

The value of cross-correlation coefficient \( \gamma \) ranges from -1 to +1 corresponds to completely not matched and completely matched respectively. For template matching the template, \( T \) slides over \( I \) and \( \gamma \) is calculated for each coordinate \((x,y)\). After calculation, the point which exhibits maximum \( \gamma \) is referred to as the match point.

4.2 HUMAN BODY PARTS TEMPLATE MATCHING

A template is simply a smaller image. Typically template matching is only used in highly controlled environments. A template matching algorithm works by computing a fit score for each pixel in the image and then looking for local maximums. The tested images for various characteristic for sample real time image1,2 and 3 are given below.

In image 1 the legs are folded. In image 2 hands are fully covered by the dress. In image 3 the left hand is inside the pocket. The below figure 3 shows the full image(a) and template image of face(b), left hand(c), right hand(d), left leg(e) and right leg(f) in image 1. The figure 4 shows the template matching of Image 1.
**Figure 3.** Template of Human Body Parts in Image 1

(a) Full image of Image 1  
(b) Face  
(c) Left hand  
(d) Right hand  
(e) Left leg  
(f) Right leg  

(a) Template matching of face  
(b) Template matching of left hand
The below figure 5 shows the full image(a) and template image of face(b), left hand(c), right hand(d), left leg(e) and right leg(f) in image II. The figure 6 shows the template matching of Image 2.

Figure 4. Template matching of Human Body Parts in Image 1

Figure 5. Template of Human Body Parts in Image 2
Template Matching in Human Body Parts Recognition using Correlation

(a) Template matching of face
(b) Template matching of left hand
(d) Template matching of right hand
(f) Template matching of left leg
(g) Template matching of right leg

**Figure 6.** Template matching of Human Body Parts in Image 2
The below figure 7 shows the full image(a) and template image of face(b), left hand(c), right hand(d), left leg(e) and right leg(f) in image 3. The figure 8 shows the template matching of Image 3.

(a) Full image of Image 3  
(b) Face  
(c) Left hand  
(d) Right hand  
(e) Left leg  
(f) Right leg

**Figure 7.** Template of Human Body Parts in Image 3
Template Matching in Human Body Parts Recognition using Correlation

Figure 8. Template matching of Human Body Parts in Image 3

The following figure 9 shows the original image (a), orientation of the original image (b) at 45 degree (c) at 180 degree and the proposed algorithm using template matching technique the resulting figure (d) and (e) for extraction of human face. This shows that the proposed algorithm is rotation invariant.
5. RESULTS AND CONCLUSION

The cross-correlation coefficient algorithm is applied for solving object recognition problem. In this research work the performance has been studied for number of human images with templates. The work was tested on a sample of twenty images from the database of 200 images for each and every parts of human body. Table 1 summarizes the time taken for the various human body parts recognition. The average time taken for the twenty samples are listed in Table 2. Correlation based algorithms are tested on three real time images, and it is found that in these algorithm the time taken for finding the position of face object is high in images (refer Figure 4, 6 and 8).

The proposed algorithm successfully employed the cross-correlation method to solve the object recognition problem. The simple template matching algorithm presented here has achieved promising results of recognition rates and the time taken for each recognition around 0.07 seconds to 0.09 seconds. The maximum cross-correlation coefficient value indicate the perfect matching of extracted object with the target image. The system successfully recognized the various objects at different altitudes and orientation.

Table 1: Time taken for object recognition

<table>
<thead>
<tr>
<th>Human Object</th>
<th>Time taken in seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Image I</td>
</tr>
<tr>
<td>Face</td>
<td>0.123881</td>
</tr>
<tr>
<td>Left Hand</td>
<td>0.076225</td>
</tr>
<tr>
<td>Right Hand</td>
<td>0.078784</td>
</tr>
<tr>
<td>Left Leg</td>
<td>0.079029</td>
</tr>
<tr>
<td>Right Leg</td>
<td>0.078334</td>
</tr>
</tbody>
</table>

Figure 9. Different views of a human and Template matching
Table 2: Average time taken for object recognition

<table>
<thead>
<tr>
<th>Human Object</th>
<th>Time taken in seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face</td>
<td>0.091198</td>
</tr>
<tr>
<td>Left Hand</td>
<td>0.077942</td>
</tr>
<tr>
<td>Right Hand</td>
<td>0.078733</td>
</tr>
<tr>
<td>Left Leg</td>
<td>0.079441</td>
</tr>
<tr>
<td>Right Leg</td>
<td>0.080369</td>
</tr>
</tbody>
</table>

Figure 10 shows the variation in recognition time for a range of different values of human body parts because the templates of human body parts is various size and various illuminations. The result of table 1 is shown graphically using bar chart in figure 10.

![Time Taken in Seconds](image)

**Figure 10.** Plot of the Human body parts

The cross correlation algorithm could be extended for multiple target, multiple template recognition with reasonable computational time. The other methods of object recognition like normal correlation coefficient can be attempted in future.
REFERENCES


